Digital PID Controller

# *AI-400,AI-700,AI-800,AI-900*
# INSTRUCTION MANUAL

**MIC3AI-E1**

Carefully read all the instructions in this manual. Please place this manual in a convenient location for easy reference.

**WARNING**

- An external protection device must be installed if failure of this instrument could result in damage to the instrument, equipment or injury to personnel .
- All wiring must be completed before power in turned on to prevent electric shock, fire or damage to instrument and equipment .
- This instrument must be used in accordance with the specifications to prevent fire or damage to instrument and equipment.
- This instrument is not intended for use in locations subject to flammable or explosive gases.
- Do not touch high-voltage connections such as power supply terminals , etc. to avoid electric shock.

**CAUTION**

- This instrument is protected from electric shock by reinforced insulation. Provide reinforced insulation between the wire for the input signal and the wires for instrument power supply, source of power and loads.
- This instrument is design for installation in an enclosed instrumentation panel. All high-voltage connections such as power supply terminals must be enclosed in the instrumentati on panel to avoid electric shock by operating personnel.
- All precautions described in this manual should be taken to avoid damage to the instrument or equipment.
- All wiring must be in accordance with local codes and regulations.
- Always observe precautions described in this manual. Otherwise serious injury or accident may result.
- Do not allow metal fragments or lead wire scraps to fall inside this instrument. This may cause electric shock, fire or malfunction.
- Firmly tighten each terminal screw at the specified torque. Otherwise electric shock or fire may result.
- Do not place any obstacle around this instrument in order not to impede radiation of heat. And do not close ventilation holes.
- Do not connect wires to unused terminals.
- Before cleaning the instrument, always turn off the power supply.
- Remove stains from this instrument using a soft, dry cloth. Do not use a volatile solvent such as thinner in order to avoid deformation or discoloration.
- Do not rub nor strike the display unit of this instrument with a hard object.

# 1. PRODUCT CHECK

AI-400 (Size:48x48mm)
AI-800 (Size:48x96mm)
AI-700 (Size:72x72mm)
AI-900 (Size:96x96mm)

□□□□-□□*□□-□
(1) (2) (3) (4) (5) (6) (7) (8)

(1) Control action
F: PID reverse action with autotuning

(2) Input type, (3) Range code: See "8.INPUT RANGE TABLE"

(4) Control output [OUT]:
M: Relay contact V: Voltage pulse
8: Current (DC4 ~ 20 mA) 5: DC0-5VDC
6: DC0-10VDC T: Zero trigger (for triacs driving)

(5) Remark: N: No

(6) Alarm 1 [AL1 for high alarm] See "5.5 Initial Setting"
N: No alarm
A: Deviation high alarm H: Process high alarm
B: Low deviation alarm J: Process low alarm

(7) Alarm 2 [AL2 for low alarm] See "5.5 Initial Setting"
N: No alarm
A: Deviation high alarm H: Process high alarm
B: Low deviation alarm J: Process low alarm

(8) Power
A: 220VAC B: 85-265VAC D: 24VDC E: 24VAC

〈Example〉

Model: AI-900
Code: FKA4-MN*AN-B

Check MODEL and CODE is very important when ordering.

Specification:
Model of the controller: AI-900
Size: 96mm x 96mm
Control action: PID reverse action
Input: K type thermocouple
Out put: Relay output
Alarm: 1 deviation high alarm (AL1)
Power: 85~265VAC

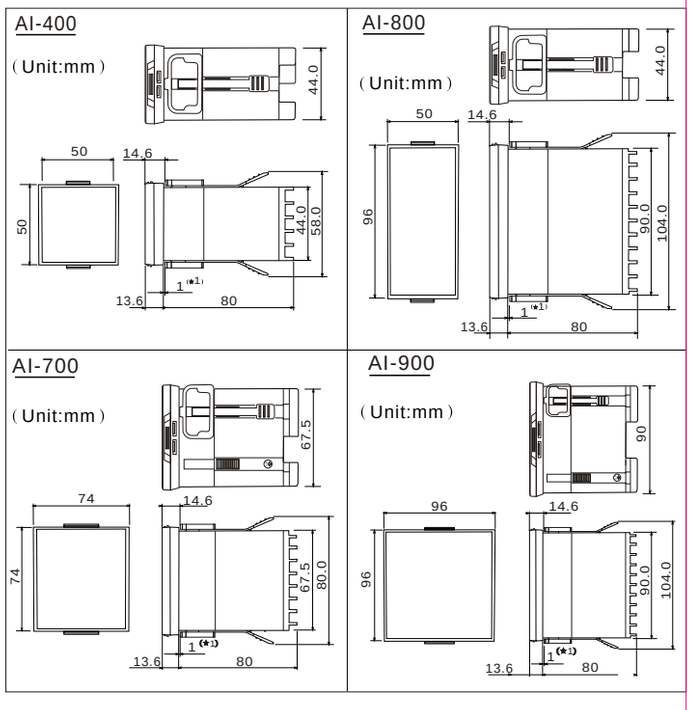
# 2. MOUNTING

## 2.1 Mounting Cautions

(1) Use this Instrument within the following ambient temperature and ambient humidity.
- Allowable ambient temperature: 0 to 50°C
- Allowable ambient humidity: 45 to 85% RH

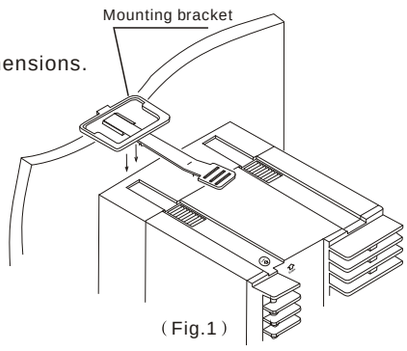
(2) Avoid the following when selecting the mounting location.
- Rapid changes in ambient temperature which may cause condensation.
- Corrosive or inflammable gases.
- Direct vibration or shock to the mainframe.
- Water, oil, chemicals, vapor or steam splashes.
- Excessive induction noise, static electricity, magnetic fields or noise.
- Direct air flow from an air conditioner.
- Exposure to direct sunlight.
- Excessive heat accumulation.

## 2.2 Dimensions

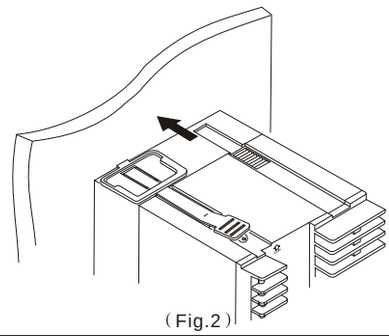


## 2.3 Mouting Procedures

(1) Prepare the panel cutout as specified in 2.2 Dimensions.
(2) Insert the instrument through the panel cutout.
(3) insert the mounting bracket into the mounting groove of the instrument. (Fig.1)
(4) Pull till chick sounds to the direction shown by the arrow.(Fig.2)
(5) The other mounting bracket should be installed the same way described in 3. to 4.



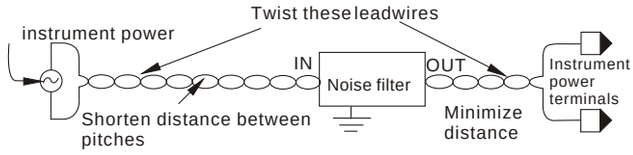
(Fig.1)


(Fig.2)

# 3. WIRING

## 3.1 Wiring cautions

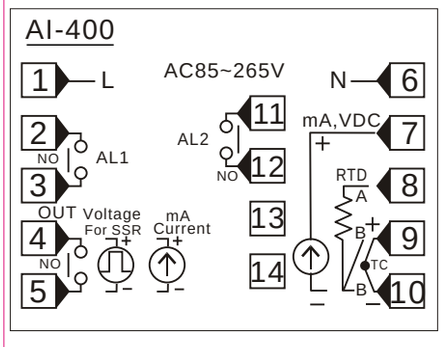
(1) For thermocouple input, use the specified compensation wire.
(2) For RTD input , use leads with low resistance and having no resistance differences among the 3 leads.
(3) Conduct input signal wiring away from instrument power, electric equipment power and load lines to avoid noise induction.
(4) Conduct instrument power wiring so as not to be influenced by noise from the electric equipment power. If the instrument may be affected by external noise, a noise filter should be used.
* Shorten the distance between twisted power supply wire pitches. The shorter the distance between the pitches, the more effective for noise reduction.
* Install the noise filter on the panel which is always grounded and minimize the wiring distance between the noise filter output side and the instrument power terminals.

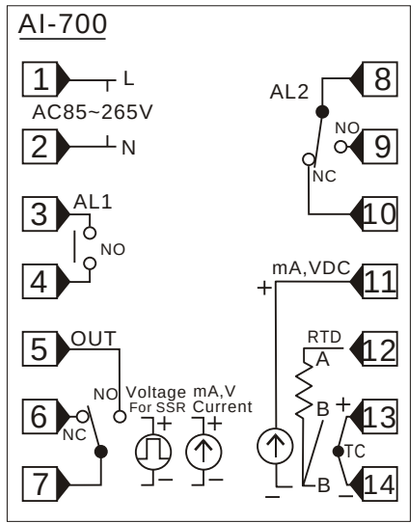


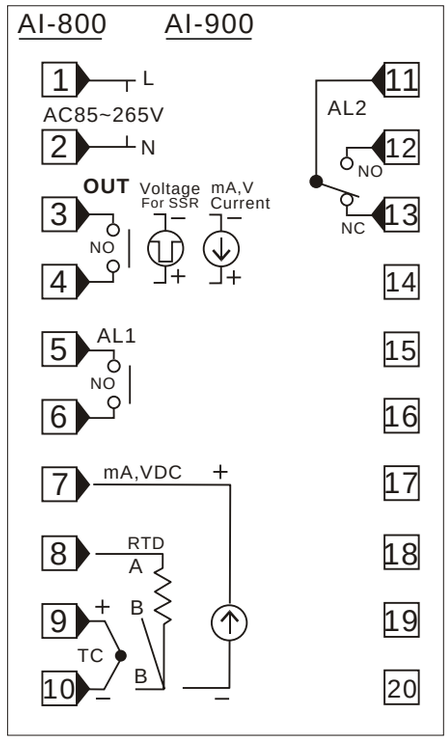

* Do not install fuses and/or switches on the filter output signal since this may lessen filter effect.
(5) For wiring, use wires conforming to the domestic standard of each country.
(6) Abot 4 to 5 seconds are required as the preparation time for contact output after power on. Use a delay relay when the output line is used for an external interlock circuit.
(7) This instrument has no power supply switch nor fuses. Therefore, install the fuse close to the instrument and the switch, if required.
*Recommended fuse rating: Rated voltage; 250V Rated current; 1A * Fuse type; Time-lag fuse
(8) Do not excessively tighten the terminal screws. In addition, use the solderless terminal appropriate to the screw size.
(9) To the instrument with power supply of 24V, please be sure to supply the power from SELV circuit.

## 3.2 Terminal Configuration

**CAUTION**
(1)All the under hookups are only for reference.
(2)For wiring, please according to the hookup label which was glued on the plastic case of controller.




**Power supply voltage:**
AC85~265V
(Frequency: 50/60Hz, Rating: 85~265V Ac)
22 to 26 V AC
(Frequency: 50/60Hz, Rating: 24V AC)
22 to 26V DC (Rating: 24V Dc)

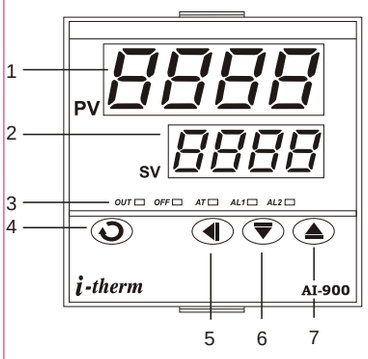
**Power consumption**:
5VA max (at 24V AC) 160mA max (at 24V DC)
7VA max(at 100V AC) 10VA max (at 240V AC)

**Alarm outut rated:**
Relay contact output: 250V AC, 3A (Resistive load)

**Control output rated**:
Relay contact output: 250V AC,3A(Resistive load)
Voltage pulse output: 0/12 V DC (Load resistance 600 Ω or more)
Current output: 4 to 20mA DC (Load resistance 500 Ω or less)
Trigger output(for triac driving):100A or less

**For the current input (0-20mA or 4-20mA) specification, a resistor of 500Ω must be connected between the input terminals. See 5.6 ****A "INPUT TYPE SYMBOL TABLE"**

# 4. PARTS DESCRIPTION




1. Measured value (PV) display [Green]
   * Displays PV or various parameter symbols
2. Set value (PV) display [Red]
   * Displays SV or various parameter set values
3. Indication lamps
   *Control output lamps (OUT, OFF)
   [Green] OUT: Light when output is turned on.
   [Red] OFF: Light when output is turned off.

*Autotuning (AT) [Green]
Flashes when autotuning is activated.

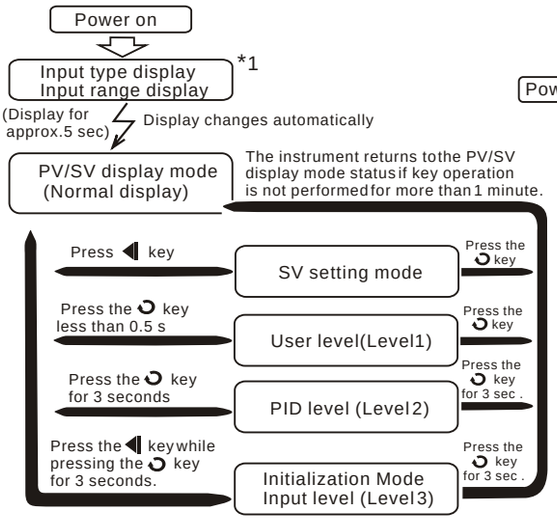
*Alarm output lamps (AL1, AL2) [Red]
AL1: Lights when alarm 1 output is turned on.
Al2: Lights when alarm 2 output is turned on.

4. (Set key)
   Used for parameter calling up and set value registration
5. ◀ Shift & Assistant key
6. ▼ (Down key)
   Decrease numbers
7. ▲ (Up key)
   Decrease numbers

**CAUTION** To avoid damage to instrument, never use a sharp object to press keys.

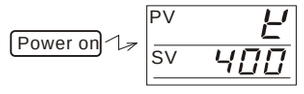
# 5. SETTING

## 5.1 Calling up procedure of each mode




***1. Input type and input range display**

This instrument immediately confirms input type and range following power on.
Example: For a controlleer with the K thermocouple input type and range from 0 to 1300°C.




1. Input type display
   : Indicates input type (See table **A)
   400 : Input range high

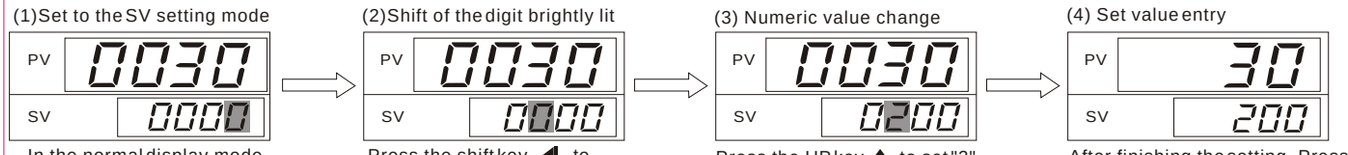
****A: Input type table (see "14.0 Input range table")**

| Display | | | | | | | |
|---|---|---|---|---|---|---|---|
| Input | Thermocouple | | | | | | |
| | K | J | E | S | T | B | R |

| Display | | | |
|---|---|---|---|
| Input | Resistance thermometer | Standard analog signal (Voltage and current) | |
| | Pt100 | DC0-10V, DC 0-20mA | DC2-10V, DC 4-20mA |

## 5.2 Setting set value (SV)

Example: Following is an example of set value (SV) to 200°C

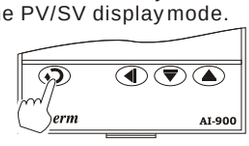



**Caution** *Even if the displayed value is changed, it is not registered. To register it, press the SET key.

## 5.3 Setting parameters other than set value (SV)

The setting procedures are the same as those of example (2) to (4) in the above "Setting set value (SV)". Press the SET key after the setting end shifts to the next parameter. When no parameter setting is required, return the instrument to the PV/SV display mode.

## 5.4 User level (Level1)




5.4.1 User level parameter setting mode.

Press the "**SET** "key once less than 0.5 s to go to user level.

The following parameter symbols are displayed one by one every time the key is pressed.

**#1: Factory set value**

| Symbol | Name | Setting range | Description | #1 |
|---|---|---|---|---|
| AL 1 | Alarm1 (AL1) | Deviation or Process alarm, -1999 to 9999 | Set the alarm value for alarm1 or alarm2. Alarm differential gap=HYS, when P≠0 | 10 or 10.0 |
| AL2 | Alarm2 (AL2) | | | |
| At | Auto tuning (At) | 0: AT end or cancel<br>1: AT start or execution | Use AT function to automatically calculate and set the optimize PID value for your system. Turns the autotuning ON/OFF | 0 |

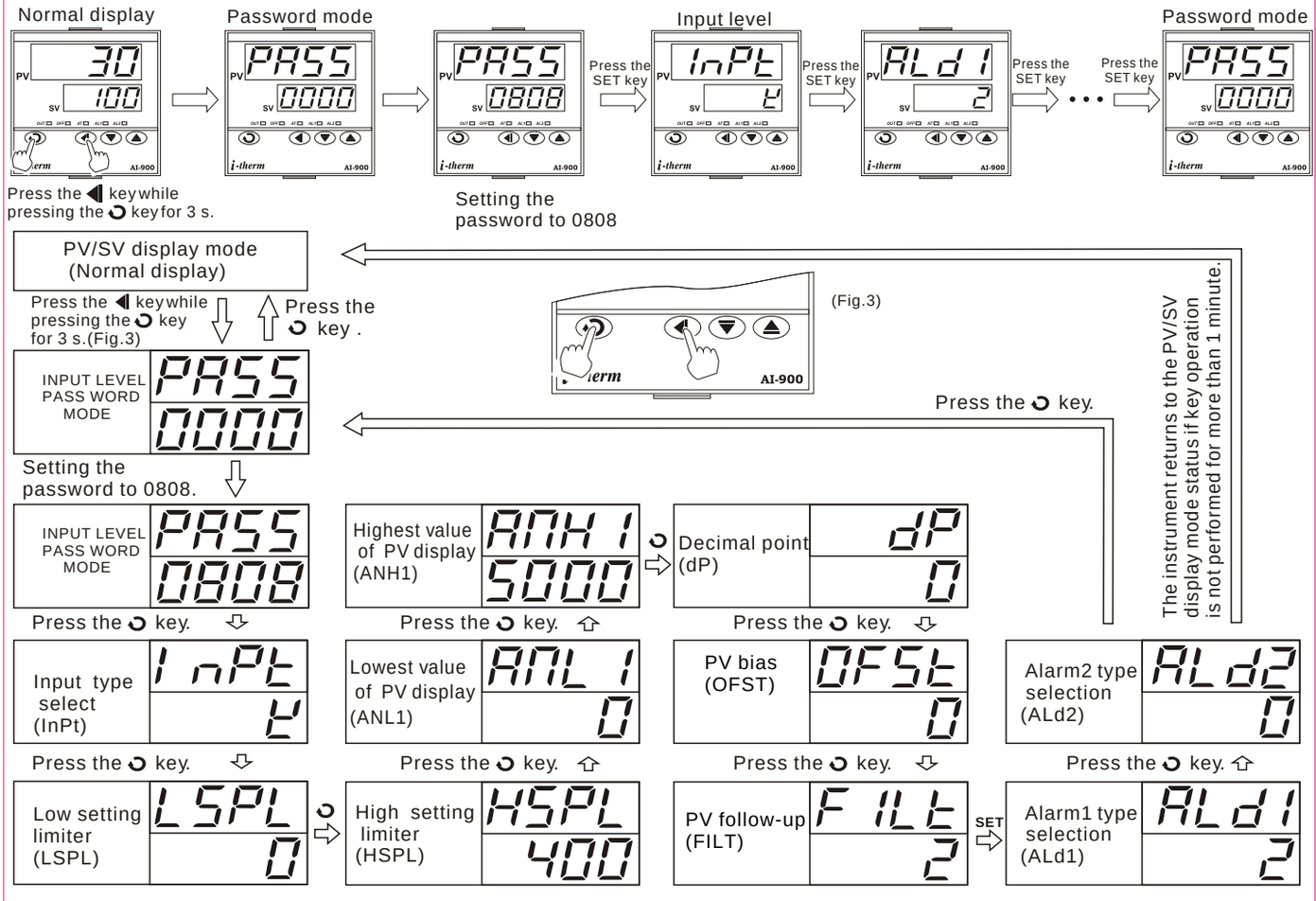
## 5.5 PID level (Level2)

Press the ↻ key for 3 seconds to PID level.
After the value be registered ,you can press ↻ key for 3 seconds to return the instrument to the PV/SV display mode.
The following parameter symbols are displayed one by one every time the ↻ key is pressed.

**#1: Factory set value**

| Symbol | Name | Setting range | Description | #1 |
|---|---|---|---|---|
| P | Proportional band (P) | 0.0~999.9 | ON/OFF control if set to 0 (0.0)<br>ON/OFF action differential gap=HYS | 20.0 |
| HYS | Differential gap for alarm or output (HYS) | 0 to 9999 | Out differential gap=HYS, when P=0 (ON/OFF action)<br>Alarm differential gap=HYS, when P ≠ 0 (PID action) | 0 |
| I | Integral time (I) | 0~3600 seconds | Set the time of integral action to eliminate the offset occurring in proportional control. | 150 |
| d | Derivative time (d) | 0.0~999.9 seconds | Set the time of derivative action to improve control stability by preparing for output changes. | 30.0 |
| CYCt | Proportioning cycle (CYCt) | 1.0~200.0 seconds | Relay contact output: 20S<br>Voltage pulse (for SSR) : 2S | 20.0<br>or 2.0 |
| OPL | Output manipulated variable lowest limit (OPL) | Output manipulated variable lowest limit .<br>Range : 0 to 100% | | 0 |
| OPH | Output manipulated variable highest limit (OPH) | Output manipulated variable highest limit .<br>Range : 0 to 100% | | 100 |
| Ar | Proportional reset (Ar) | Overshooting restricted by the proportional effect. | | 10 or 10.0 |
| OFF | Overshooting turn off (OFF) | Output forced turning off when the PV value overshooting .<br>（Setting range: 0 to 100） | | 3 |
| LCK | Set data lock (LCK) | 0: All parameters can be changed<br>1: Only SV can be changed<br>2: No parameters can be changed | Performs set data change enable/disable. | 0 |

## 5.6 INPUT Level (Level 3)(Initial Setting )



After the value be registered ,when no parameter setting is required, Press the ↻ key for 3 s to return the instrument to the normal display.

The following parameter symbols are displayed one by one every time the ↻ key is pressed.

**#1: Factory set value**

| Symbol | Name | Description | #1 |
|---|---|---|---|
| InPt | Main input type select (InPt) | Input type selection as:thermocouple(TC),RTD,etc. See ****A "INPUT TYPE SYMBOL TABLE"** | K |
| LSPL | Low setting limiter (LSPL) | Set lower point within input see 14. chapter "INPUT RANGE TABLE" | 0 |
| HSPL | High setting limiter (HSPL) | Set higher point within input see 14. chapter "INPUT RANGE TABLE" | 400 |
| ANL 1 | Lowest value of PV display (ANL1) | Lowest value display when analog signal inputs,Such as 4-20mA input. The value of PV display when input 4 mA. Only for standard analog signal input. | 0 |
| ANH 1 | Highest value of PV display (ANH1) | Highest value display when analog signal inputs,Such as 4-20mA input. The value of PV display when input 20 mA. Only for standard analog signal input. | 5000 |
| dP | Decimal point (dP) | Only for standard analog signal input (current or voltage inputs) . Range:0~3 | 0 |
| OFSt | PV bias (OFSt) | Sensor correction is made by adding bias value to measured value(PV). | 0 |
| FILt | PV follow-up (FILt) | PV variable-value control, （Setting range: 0 to 10） PV will response slower if SOFT is bigger. | 2 |
| ALd1 | Alarm1 type selection (ALd1) | Select the type of alarm1 range:0~4 See ****B "ALARM TYPE TABLE"** | 2 |
| ALd2 | Alarm2 type selection (Ald2) | Select the type of alarm2 range:0~4 See ****B "ALARM TYPE TABLE"** | 0 |

## **A: INPUT TYPE SYMBOL TABLE

| InPt Setting | K | J | E | S | T | B | R | Pt | U1 | U2 |
|---|---|---|---|---|---|---|---|---|---|---|
| Input type | K | J | E | S | T | B | R | Pt100 | DC0-10V,(**DC 0-20mA) | DC2-10V,(**DC 4-20mA) |
| Range | -50 to1350°C | -50 to1000°C | -50 to1000°C | -50 to 1750°C | -20 to400°C | 50 to1800°C | -20 to1750°C | -199.9 to600.0°C | -1999 to9999 | -1999 to9999 |

1,All input change in the above groups is possible by keyboard.

2**,For the current input (0-20mA or 4-20mA) specification, a resistor of 500Ω must be connected between the input terminals.

## **B: ALARM TYPE TABLE

▲:SV △:Alarm set value

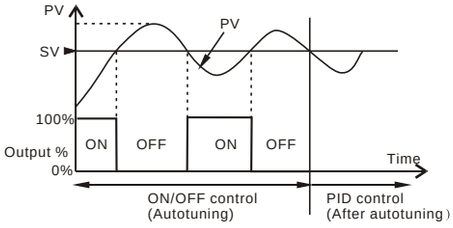
| CODE | ALd1 | Alarm1 mode specification | | CODE | ALd2 | Alarm2 mode specification | |
|---|---|---|---|---|---|---|---|
| N | 0 | No Alarm | | N | 0 | No Alarm | |
| A | 2 | AL1⩾0 | Deviation high alarm: HYS, Alarm ON; LOW, SV▲, △SV+AL1, HIGH | A | 2 | AL2⩾0 | Deviation high alarm: HYS, Alarm ON; LOW, SV▲, △SV+AL2, HIGH |
| | | AL1<0 | Deviation high alarm: HYS, Alarm ON; LOW, △SV+AL1, ▲SV, HIGH | | | AL2<0 | Deviation high alarm: HYS, Alarm ON; LOW, △SV+AL2, ▲SV, HIGH |
| B | 4 | AL1⩾0 | Low deviation alarm: Alarm ON, HYS; LOW, SV-AL1△, SV▲, HIGH | B | 4 | AL2⩾0 | Low deviation alarm: Alarm ON, HYS; LOW, SV-AL2△, SV▲, HIGH |
| | | AL1<0 | Low deviation alarm: Alarm ON, HYS; LOW, SV▲, △SV-AL1, HIGH | | | AL2<0 | Low deviation alarm: Alarm ON, HYS; LOW, SV▲, △SV-AL2, HIGH |
| H | 1 | Process high alarm: HYS, Alarm ON; LOW, △AL1 AL1Value, HIGH | | H | 1 | Process high alarm: HYS, Alarm ON; LOW, △AL2 AL2Value, HIGH | |
| J | 3 | Process low alarm: Alarm ON, HYS; LOW, △AL1 AL1Value, HIGH | | J | 3 | Process low alarm: Alarm ON, HYS; LOW, △AL2 AL2Value, HIGH | |

NOTE: Alarm differential gap=HYS,when P≠0(PID action)

# 6. PID AUTOTUNING (AT) FUNCTION

■ **Autotuning (AT) start**

1) Press the ↺ key for USER level.
2) Looking for the parameter "AT ".
3) Set "AT" value from 0 to 1.
4) Press the ↺ key start autotuning.
5) Press the ↺ key to return to the instrument to the PV/SV display mode.
(If AT be started ,the AT lamp will be lighted on and the lamp is flashing)




Autotuning (AT) automatically measures, calculates and sets the optimum PID. The following conditions are necessary to carry out autotuning and the conditions which will cause the autotuning to stop.

Caution for using the Autotuning (AT)
When a temperature change(UP and/or Down) is 1℃ or less per minute during Autotuning, Autotuning may be cancelled before calculating PID values. In that case, adjust the PID values manually. It is possible to happen when the set value is around the ambient temperature or is close to the maximum temperature achieved by the load.

■ **Requirements for AT start**

Start the autotuning when all following conditions are satisfied:
(1) Prior to starting the AT function, end all the parameter settings other than PID.
(2) Confirm the LCK function has not been engaged.

When the autotuning is finished, the controller will automatically return to PID control.

■ **Requirements for AT cancellation**

The autotuning is canceled if any of the following conditions exist.
(1) When the parameter "AT " value is changed.
(2) When the power is turned off.
(3) When power failure longer than 20ms occurs.

If the AT is canceled, the controller immediately changes to PID control. The PID values will be the same as before AT was activated.

When AT is completed, the controller immediately changes to PID control. If the control system does not allow the AT cycling process, set each PID constant manually to meet the needs of the application.

# 7.ERROR DISPLAYS

■ **Error display**

| | | |
|---|---|---|
| Erro [Flashing] | RAM failure(Incorrect set date write or check sensor and sensor connection,etc.) | Turn off the power once. If an error occurs after the power is turned on again, please contact sales office or the agent. |

■ **Overscale and Underscale**

| | | |
|---|---|---|
| Measured value(PV) [Flashing] | PV is outside of input range | ⚠ WARNING<br>To prevent electric shock, always turn off the power before replacing the sensor.<br><br>Check input type, input range, sensor and sensor connection.. |
| HHHH [Flashing] | **Overscale:**<br>PV is above the high input display range limit. | |
| LLLL [Flashing] | **Underscale:**<br>PV is below the low input display range limit. | |

# 8. INPUT RANGE TABLE

| Input type | | | | Code | |
|---|---|---|---|---|---|
| K | 0 | to | 100 ℃ | K | A1 |
| | 0 | to | 200 ℃ | K | A2 |
| | 0 | to | 400 ℃ | K | A4 |
| | 0 | to | 600 ℃ | K | A6 |
| | 0 | to | 800 ℃ | K | A8 |
| | 0 | to | 1000 ℃ | K | A0 |
| | 0 | to | 1300 ℃ | K | B3 |
| | 0 | to | 1350 ℃ | K | B4 |

| Input type | | | | Code | |
|---|---|---|---|---|---|
| J | 0 | to | 100 ℃ | J | A1 |
| | 0 | to | 200 ℃ | J | A2 |
| | 0 | to | 300 ℃ | J | A3 |
| | 0 | to | 400 ℃ | J | A4 |
| | 0 | to | 600 ℃ | J | A6 |
| | 0 | to | 800 ℃ | J | A8 |
| | 0 | to | 1000 ℃ | J | A0 |

| Input type | | | | Code | |
|---|---|---|---|---|---|
| S | *1 0 | to | 1000 ℃ | S | A0 |
| | *1 0 | to | 1600 ℃ | S | B6 |
| | *1 0 | to | 1750 ℃ | S | B8 |

| Input type | | | | Code | |
|---|---|---|---|---|---|
| B | *1 50 | to | 1300 ℃ | B | B3 |
| | *1 50 | to | 1800 ℃ | B | B8 |

| Input type | | | | Code | |
|---|---|---|---|---|---|
| T | 0 | to | 100 ℃ | T | A1 |
| | 0 | to | 200 ℃ | T | A2 |
| | 0 | to | 300 ℃ | T | A3 |
| | 0 | to | 400 ℃ | T | A4 |

| Input type | | | | Code | |
|---|---|---|---|---|---|
| E | 0 | to | 100 ℃ | E | A1 |
| | 0 | to | 200 ℃ | E | A2 |
| | 0 | to | 300 ℃ | E | A3 |
| | 0 | to | 400 ℃ | E | A4 |
| | 0 | to | 500 ℃ | E | A5 |
| | 0 | to | 600 ℃ | E | A6 |
| | 0 | to | 800 ℃ | E | A8 |
| | 0 | to | 1000 ℃ | E | A0 |

| Input type | | | | Code | |
|---|---|---|---|---|---|
| R | *1 0 | to | 600 ℃ | R | A6 |
| | *1 0 | to | 1000 ℃ | R | A0 |
| | *1 0 | to | 1300 ℃ | R | B3 |
| | *1 0 | to | 1750 ℃ | R | B8 |

| Input type | | | | Code | |
|---|---|---|---|---|---|
| 0 to 10VDC | -1999 | to | 9999 | V | 04 |
| 2 to 10VDC | | | | V | 09 |
| 4 to 20mA *2 | | | | A | 03 |
| 0 to 20mA *2 | | | | A | 02 |

| Input type | | | | Code | |
|---|---|---|---|---|---|
| Pt100 | 0.0 | to | 100.0 ℃ | D | D1 |
| | 0.0 | to | 200.0 ℃ | D | D2 |
| | 0.0 | to | 300.0 ℃ | D | D3 |
| | 0.0 | to | 400.0 ℃ | D | D4 |
| | 0.0 | to | 500.0 ℃ | D | D5 |
| | 0.0 | to | 600.0 ℃ | D | D6 |
| | -199.9 | to | +100.0 ℃ | D | E1 |
| | -199.9 | to | +200.0 ℃ | D | E2 |
| | -199.9 | to | +600.0 ℃ | D | E6 |
| | -100.0 | to | +100.0 ℃ | D | F1 |
| | -100.0 | to | +200.0 ℃ | D | F2 |
| | -50.0 | to | +50.0 ℃ | D | G0 |
| | -50.0 | to | +100.0 ℃ | D | G1 |
| | -50.0 | to | +200.0 ℃ | D | G2 |

(*1) 0 to 400°C: Accuracy is not guaranteed.

(*2)For the current input (0-20mA or 4-20mA) specification, a resistor of 500Ω must be connected between the input terminals.

JULY.2010.(P)

i-therm